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YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

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ANNUAL REPORT OF THE INTERAGENCY STUDY TEAM

1983 and 1984

4 ORIGINAL

National Park Service
U.S. Forest Service
Montana Fish and Game Department
U.S. Fish and Wildlife Service
Idaho Fish and Game Department
Wyoming Game and Fish Department

DC

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TABLE OF CONTENTS

Page

LIST OF TABLES iii

LIST OF FIGURES iv

INTRODUCTION 1

RESULTS 2

    Movements 2
    Observations 2
    Population Parameters 16

        Production 16
        Mortality 16
        Survivorship 21
        Sex and Age Structure 21

    Food Habits 25

        Procedures 25
        Results 27

            Scat Analysis from 1983 27
            Scat Analysis from 1984 27
            Whitebark pine cone production transects 37

LITERATURE CITED 41

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LIST OF TABLES

Table		Page
1	Status of instrumented grizzly bears, 1975-1984	3
2	Grizzly bears trapped, 1983	5
3	Grizzly bears captured, 1984	6
4	Grizzly bears monitored during 1983 and 1984	9
5	Summary of 1983 and 1984 radio-tracking and observation flights	15
6	Grizzly bear females with cubs, 1974-84	17
7	Reproductive rates, 1983 and 1984	18
8	Grizzly bear mortalities, 1970-1984	19
9	Grizzly bear mortalities, 1983 and 1984	20
10	Grizzly bear survivorship by age class, as of January 1985	22
11	Bear scat content analysis, 1983	28
12	Seasonal bear scat content analysis by major food items, 1983	30
13	Bear scat content analysis, 1984	31
14	Seasonal bear scat content analysis by major food items, 1984	34
15	Number of cones in 10 whitebark pine trees at nine locations, 1980-1984	38
16	Total annual whitebark pine cone production	39

LIST OF FIGURES

Figure Page

1 Study area boundaries and trap locations during 1983, 1984 8

2 Annual ranges of eight grizzly bears during 1983 11

3 Annual ranges of 10 grizzly bears during 1984 12

4 Verified observations of unmarked grizzly bears during 1983 13

5 Verified observations of unmarked grizzly bears during 1984 14

6 1984 age structure 23

7 Age structure comparisons from 1959-67, 1968-70, and 1984 24

8 Locations of whitebark pine cone production transects 26

9 Volumetric analysis of grizzly bear scats during summer 1984 for central Yellowstone National Park . . . 35

10 Average volumetric analysis of grizzly bear scats during summer, 1977-1984, for central Yellowstone National Park 36

INTRODUCTION

The Interagency Grizzly Bear Study Team (IGBST), initiated in 1973, is a cooperative effort of the National Park Service, Forest Service, and since 1974 the States of Idaho, Montana, and Wyoming. This research provides immediate and long range information needed by various agencies on the grizzly bears *(Ursus arctos horribilis)* that inhabit the Yellowstone system. With increasing demands on most resources in the area, it is apparent that current quantitative data on grizzly bears are urgently required for management decisions.

Earlier research on grizzlies within Yellowstone National Park provided data for the period 1959-67 (Craighead et al. 1974). However, changes in management operations by the National Park Service since 1967 - mainly the closing of open pit garbage dumps - have markedly changed some habitat and population parameters (Meagher and Phillips 1983). Thus, current research efforts are needed to define and evaluate grizzly bear population dynamics. Objectives of the study are to determine the status and trend of the grizzly bear population, the use of habitats and food items by the bears, and the effects of land management practices on the bear population.

Distribution of grizzly bears within the study area, movement patterns, and habitat use have been largely determined (Knight et al. 1984) and are now being studied on a monitoring and updating level. Efforts are being concentrated on gathering population data, determining behavior patterns, and assessing the effects of land use practices.

Movement data conclusively indicates that the existence of semi-autonomous population segments is unlikely and that the determination of population size will be difficult due to the average home range sizes of individual bears. Population trend indices appear to be more meaningful and measurable than a number estimate (Eberhardt et al., in prep.).

RESULTS

MOVEMENTS

Since 1975, 118 grizzly bears have been fitted with radio collars and monitored for varying lengths of time. Of these bears, 48 were known or suspected to be dead at the end of the 1984 field season (Table 1); 85% of these deaths were man-caused. Only 31 of the total 118 bears were known to be alive during 1984. An additional 14 bears were known alive during 1983.

During 1983, 14 different grizzlies were captured 18 times, including 5 adults, 7 subadults, and 2 cubs (Table 2). During 1984, 33 different grizzlies were captured 41 times, including 19 adults and 14 subadults (Table 3). All 18 captures during 1983 were management control actions by Yellowstone National Park and the States of Idaho, Montana, and Wyoming. Twenty-two captures during 1984 were management actions. Grizzlies were captured at 29 trap locations throughout the study area during the 2 years (Fig. 1).

During 1983, 26 bears were monitored (Table 4). Of these 26 bears, 13 ceased providing data during the year; 5 were killed or otherwise removed from the population, 4 cast their transmitters, and 4 transmitters apparently failed. Thirty-five bears were monitored during 1984 (Table 4) of which 15 ceased providing data during the year; 6 were killed or otherwise removed from the population, 7 cast their transmitters, and 2 transmitters apparently failed.

Aerial radio-tracking methods during 1983 and 1984 were not designed to gather data for determining annual home ranges of instrumented bears. Therefore, ranges could not be calculated for the majority of monitored bears. Free-ranging movements were further complicated by several long distance transplants resulting from management control actions. Figures 2 and 3 illustrate movements of bears during 1983-84 for which sufficient data were available.

OBSERVATIONS

A total of 148 and 343 unmarked grizzly bears were sighted in verified observations during 1983 and 1984, respectively (Figs. 4 and 5). During 1983, 51 were observed during aerial radio-tracking and observation flights, and 97 were observed in verified ground sightings. The following year (1984) 87 were observed during flights, and 256 were observed in verified ground observations. An additional 38 grizzlies were sighted each year in unverified observations outside Yellowstone Park. Unverified observations within Yellowstone Park are recorded in park files.

Unmarked grizzly bears were most frequently observed from the air from May through August (Table 5). The greatest number of grizzly bears per flight hour were observed from May-July in 1983, while pronounced observation peaks occurred during April and July in 1984.

Table 1. Status of instrumented grizzly bears, 1975-1984 (n = 118).

Known dead			Suspected dead			
Man-caused	Natural	Unknown	Man-caused	Natural	Off air	Active
3	12	77	7	54	1+	43
4	56	108	24	55	2	50
5	65	2 total	31	2 total	11	59
6	3 total		32		13*	67
8			75		16	70
9			5 total		19	86
10					20++	104
14					21+	106
15					23	107
17					33	109
18					34*	110
22					35+	112
25					36*	114
26					37	115
27					40++	116
28					41*	117
29					42*	118
30					44	119
38					45+	120
39					48*	121
46					51+	20 total
47					57*	
49					61+	
58					64**	
60					68*	
62					71**	
63					72**	
69					73**	
81					74**	
88					76**	
90					78+	
93					79**	
94					80**	
95					82**	
105					83+	
113					84++	
36 total					85**	
					87++	
					89++	
					91++	
					92+	
					96+	
					97+	
					98+	

Table 1. Continued.

Known dead			Suspected dead		Off air	Active
Man-caused	Natural	Unknown	Man-caused	Natural		
					99++	
					100+	
					101+	
					102++	
					103++	
					111++	
					112++	
					51 total	

*Last known alive in 1981.
**Last known alive in 1982.
+Last known alive in 1983.
++Last known alive in 1984.

Table 2. Grizzly bears trapped, 1983.

Bear	Sex	Age	Wt[1]	Date trapped	Trap location	Release site	Trapper
10	F	12		05-23	Gardiner, MT	British Columbia	MT
93	F	1	114*	05-23	Gardiner, MT	Spruce Cr, YNP	MT
94	M	1	113*	05-23	Gardiner, MT	Pelican Cr, YNP	MT
			100	06-18	Gardiner, MT	Dispatched/injury	MT
95	M	1	100*	05-23	Gardiner, MT	Pelican Cr, YNP	MT
			100	06-18	Gardiner, MT	Two Ocean, YNP	MT
			120	07-07	Madison Jct., YNP	Control/Missoula	YNP
15	M	12		06-26	Rainbow Point, MT	Control/dispatched	MT
99	M	SAd	215*	08-07	Turpin Meadows, WY	Coulter Cr, WY	WY
88	M	6	325	08-12	Fishing Bridge, YNP	Trapper Cr, YNP	YNP
60	F	6	262*	08-22	West Yellowstone, MT	Control/zoo	MT
G17	F	Cub	35	08-22	West Yell., MT	Accidental death	MT
100	F	Cub	50	08-22	West Yell., MT	Mirror Plateau, YNP	MT
67	F	2	140*	08-24	Cooke Pass, MT	Nez Perce Cr, YNP	MT
				08-27	Old Faithful, YNP	Joseph Pk, YNP	YNP
38	F	12	350	09-08	Big Springs, ID	Antelope Cr, YNP	ID
101	F	1	155*	09-08	Big Springs, ID	Antelope Cr, YNP	ID
102	F	1	155*	09-08	Big Springs, ID	Antelope Cr, YNP	ID

[1] Weight in pounds; * indicates scale weight.

Table 3. Grizzly bears captured, 1984.

Bear	Sex	Age	Wt	Capture date	Capture location	Release site
20	M	11	440*	06-06	Richards Pond, YNP	On site
38	F	13	375*	06-04/10	Richards Pond, YNP	On site
			400*	07-12	Richards Pond, YNP	On site
			450	09-03	Jesse Cr, ID (management)	Accidental death
40	M	9	375	06-03	Nez Perce Cr, YNP	On site
43	F	7	275*	07-17	S. Crandall, Shoshone NF	On site
50	F	10	275	06-03	Nez Perce Cr, YNP	On site
			-	09-17	West Yellowstone, MT (management)	Turbid Lake road
59	F	6	220*	06-16	Antelope Cr, YNP	On site
			225	07-05	Antelope Cr, YNP	On site
67	F	3	225	09-15	West Yellowstone, MT (management)	Blacktail, YNP
			275	10-10	Papich res., N of Gardiner, MT (mgt)	Turbid Lake, YNP
70	M	6	375	08-31	Canyon, YNP (management)	Two Ocean, YNP
84	M	22	525	05-24	Nez Perce Cr, YNP	On site
86	F	14	200*	07-05	Antelope Cr, YNP	On site
88	M	7	375	08-18	Fishing Bridge, YNP (management)	Management kill
93	F	2	200	08-01	Indian Cr Campground, YNP (management)	To zoo
102	F	2	160	06-17	Richards Pond, YNP	On site
103	M	10	420*	06-07	Antelope Cr, YNP	On site
104	F	2	165*	05-26	Crow Cr/N Fk Shoshone, Shoshone NF	On site
105	M	Ad	335*	06-09	Pahaska Tepee, Shoshone NF	On site
106	F	8	275*	06-10	UXU Lodge, Shoshone NF	On site
107	M	5	285*	07-02/08	S. Crandall Cr, Shoshone NF	On site

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Table 3. Continued.

Bear	Sex	Age	Wt	Capture date	Capture location	Release site
108	M	4	315*	07-12	South Crandall Cr, Shoshone NF	On site
109	F	3	250*	07-16	South Crandall Cr, Shoshone NF	On site
110	M	1	150*	07-17	South Crandall Cr, Shoshone NF	On site
111	M	1	135*	07-17	South Crandall Cr, Shoshone NF	On site
112	M	11	375	08-15	Buffalo Fork, Gallatin NF (management)	On site
113	M	2	200	08-28	Buffalo Fork picnic area, YNP (mgt)	Blacktail, YNP
			275	10-04	Lake Hotel, YNP (management)	To Flat Mountain Arm
			275	10-16	Lake residential area, YNP (management)	To zoo
114	F	2	200	08-27	Fishing Bridge, YNP (management)	Blacktail, YNP
115	M	8	400	09-08	Slough/Boulder divide, Gallatin NF (mgt)	South Entrance, YNP
116	F	10	250	09-14	West Yellowstone, MT (management)	Cub Cr, YNP
117	F	1	150	09-14	West Yellowstone, MT (management)	Turbid Lake, YNP
118	F	1	150	09-13	West Yellowstone, MT (management)	Lewis Lake divide, YNP
119	F	3	260*	09-23	Royal Teton Ranch, MT (management)	Lamar picnic area, YNP
120	F	SAd	140	09-10	Old Faithful, YNP (management)	Turbid Lake, YNP
			140	09-26	Jardine, MT (management)	Elk Park, YNP
			140	10-03	Jardine, MT (management)	Lewis R. divide, YNP
121	M	4	425	09-28	Gravelly Mountains, MT (management)	Blacktail, YNP
G19	M	1	150	09-14	West Yellowstone, MT (management)	Died

*Scale weight, in pounds.

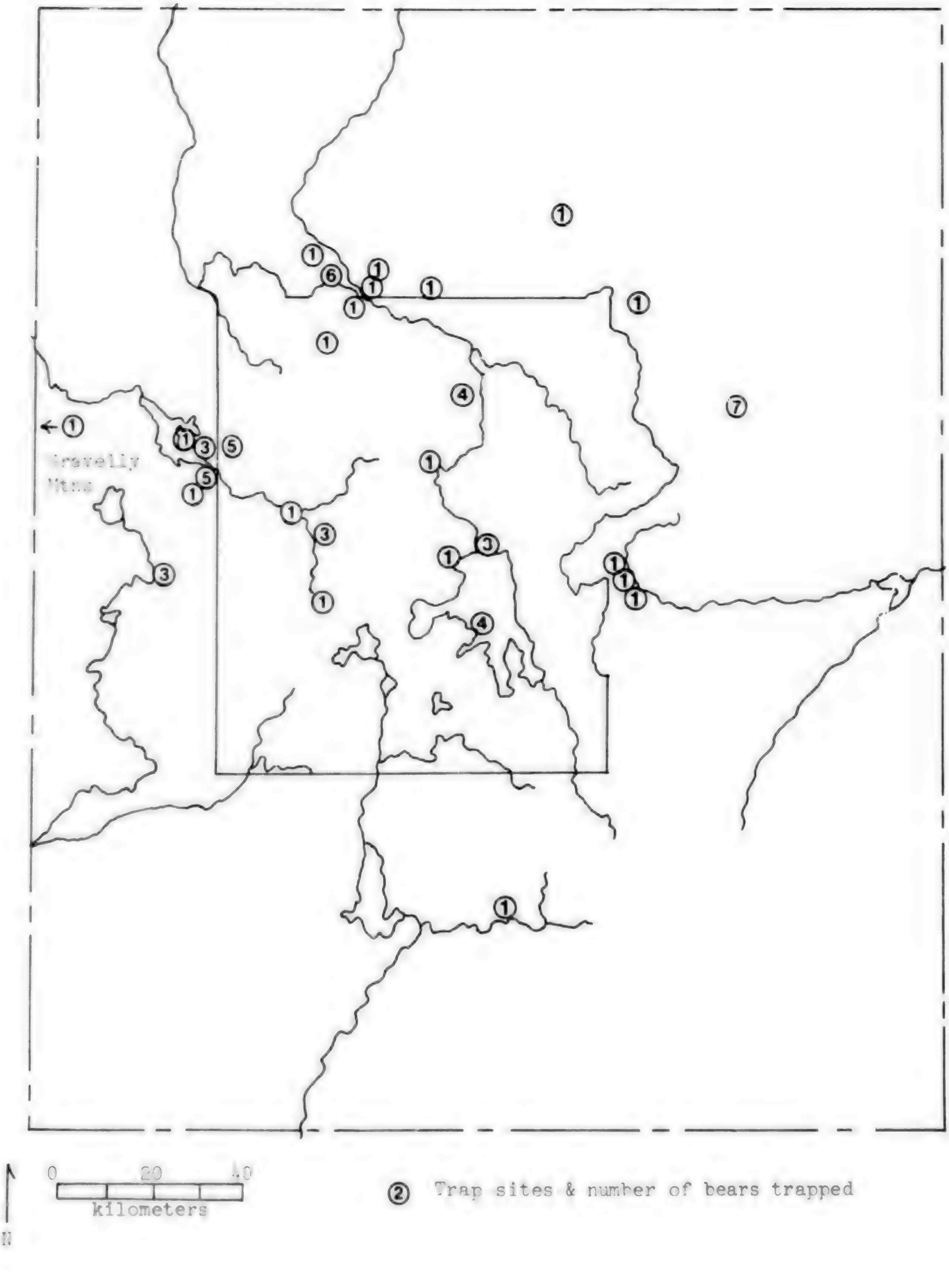


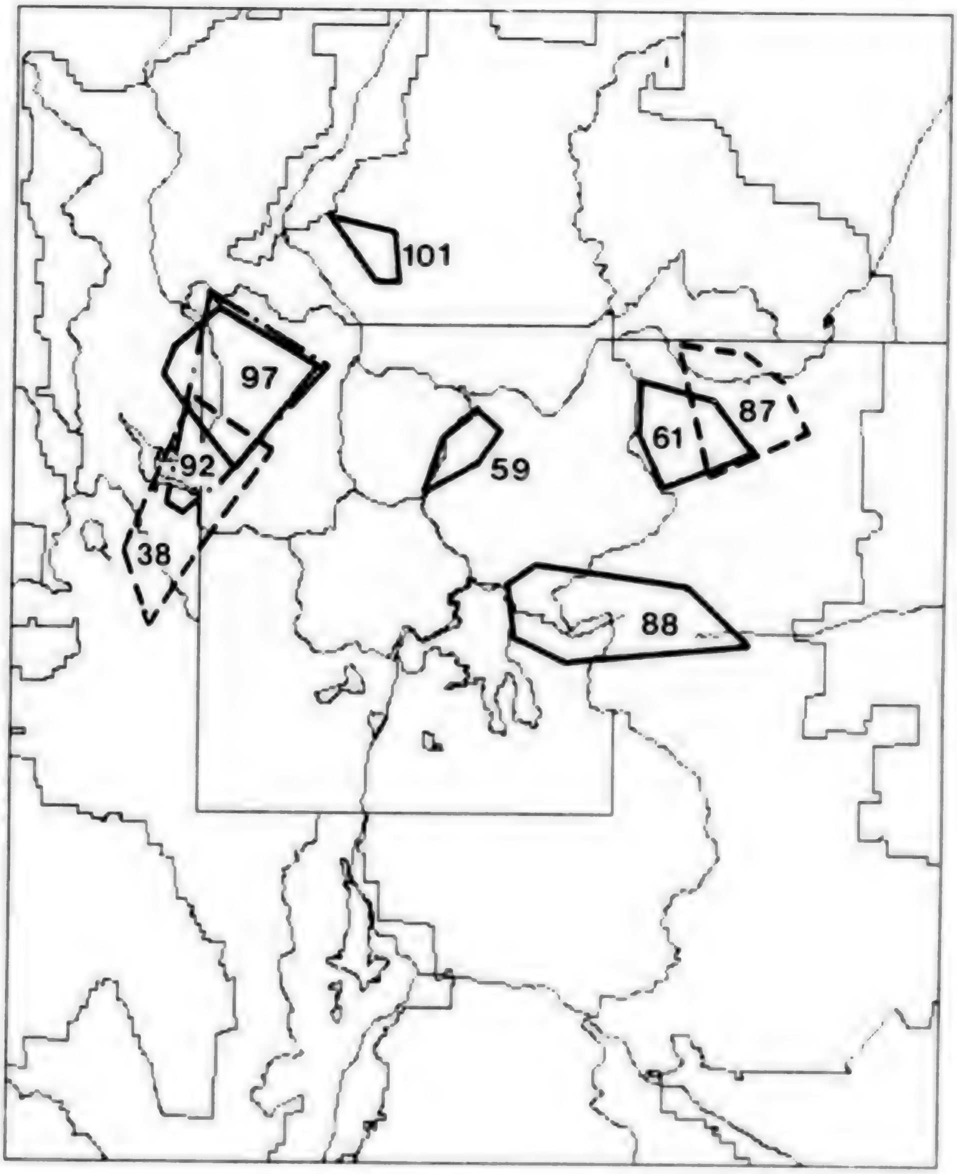
Fig. 1. Study area boundaries and trap locations during 1983, 1984.

Table 4. Grizzly bears monitored during 1983 (n = 26) and 1984 (n = 37).

Bear	Sex	Age	No. locations 1983	No. locations 1984	Interval (days) 1983	Interval (days) 1984	Range (km^2) 1983	Range (km^2) 1984
10	F	12	16	--	143	--	--	--
15	M	12	8	--	152	--	--	--
20	M	11	--	12	--	48	--	--
38	F	12,13	43	38	365	245	548	558
40	M	9	--	11	--	32	--	--
43	F	6,7	6	10	154	167	--	--
50	F	9,10	1	36	--	211	--	614
59	F	5,6	23	24	365	198	84	231
60	F	6	19	--	234	--	153	--
61	M	7	16	--	297	--	325	--
67	F	2,3	32	34	365	366	580	47
70	M	5,6	5	10	200	121	--	--
78	M	4	6	--	249	--	--	--
84	M	21,22	--	24	--	95	--	480
86	F	14	--	28	--	179	--	144
87	M	3,4	17	14	365	220	439	981
88	M	6,7	19	9	365	228	1832	--
89	M	2,3	18	2	365	5	111	--
91	F	2	13	--	365	--	--	--
92	M	4	37	--	365	--	683	--
93	F	1,2	34	25	365	212	84	135
94	M	1	5	--	169	--	--	--
95	M	1	6	--	188	--	--	--
96	M	Ad	9	--	215	--	--	--
97	F	6	30	--	365	--	500	--
98	M	SAd	7	--	230	--	--	--
99	M	SAd	8	3	146	--	--	--
100	F	Cub	5	--	131	--	--	--
101	F	1	15	--	114	--	548	--
102	F	1,2	15	37	114	130	548	526
103	M	10	--	13	--	57	--	--
104	F	2	--	22	--	128	--	137
105	M	Ad	--	15	--	112	--	1261
106	F	8	--	17	--	204	--	1002
107	M	5	--	11	--	182	--	--
108	M	4	--	3	--	99	--	--
109	F	3	--	7	--	138	--	--
110	M	1	--	?	--	138	--	--
111	M	1	--	4	--	39	--	--
112	M	11	--	?	--	138	--	--
113	M	2	--	14	--	56	--	2451
114	F	2	--	12	--	138	--	--
115	M	8	--	3	--	21	--	--
116	F	10	--	8	--	108	--	--

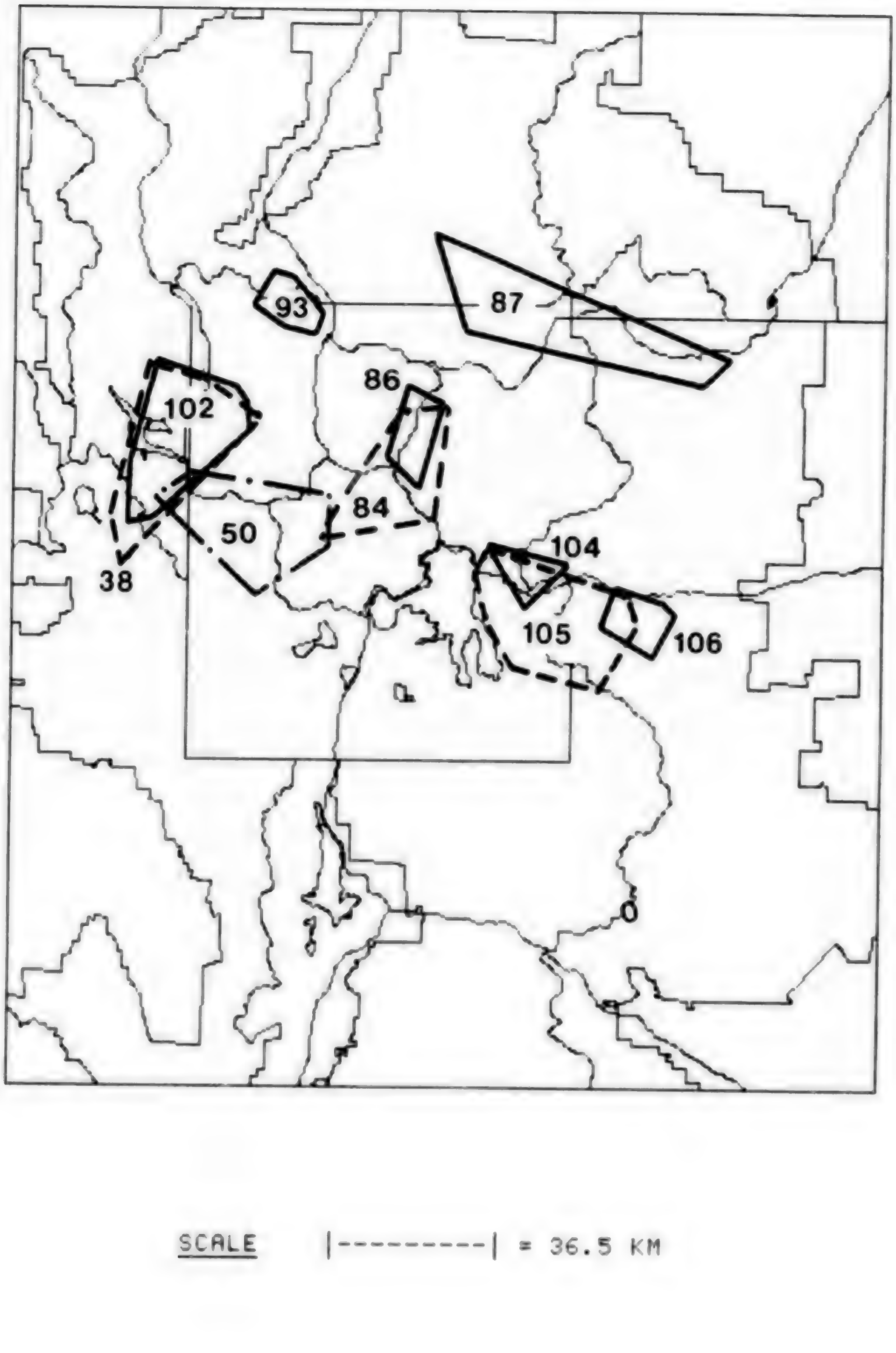
Table 4. Continued.

Bear	Sex	Age	No. locations 1983	No. locations 1984	Interval (days) 1983	Interval (days) 1984	Range (km^2) 1983	Range (km^2) 1984
117	F	1	--	[illegible]	--	108	--	--
118	F	1	--	[illegible]	--	109	--	--
119	F	3	--	[illegible]	--	99	--	--
120	F	Ad	--	[illegible]	--	112	--	--
121	M	4	--	[illegible]	--	95	--	--



SCALE |---------| = 36.5 KM

Figure 2. Annual ranges of eight grizzly bears during 1983. See Table 4 for sex and ages.



SCALE |---------| = 36.5 KM

Figure 3. Annual ranges of 10 grizzly bears during 1984. See Table 4 for sex and ages.

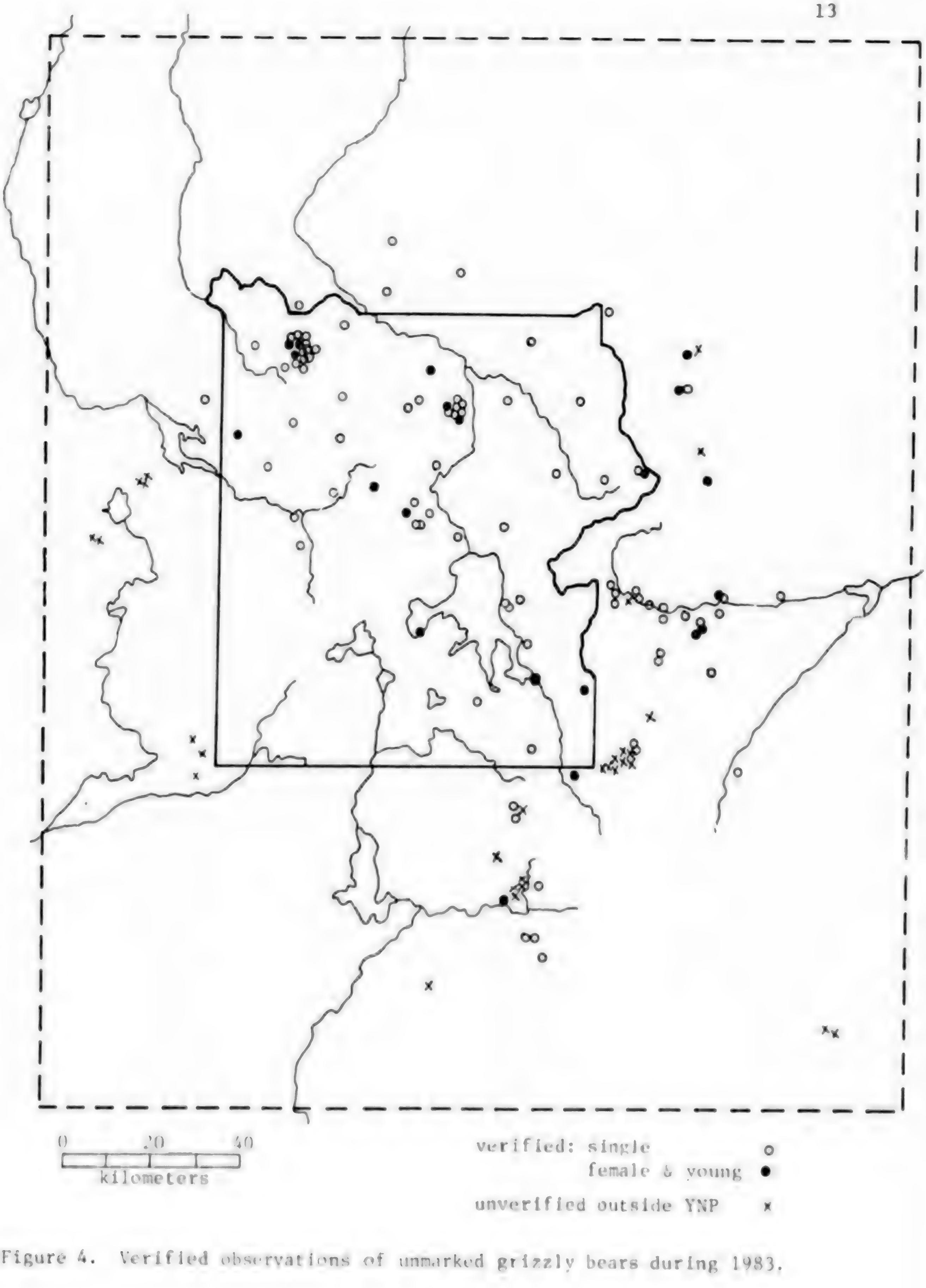


Figure 4. Verified observations of unmarked grizzly bears during 1983.

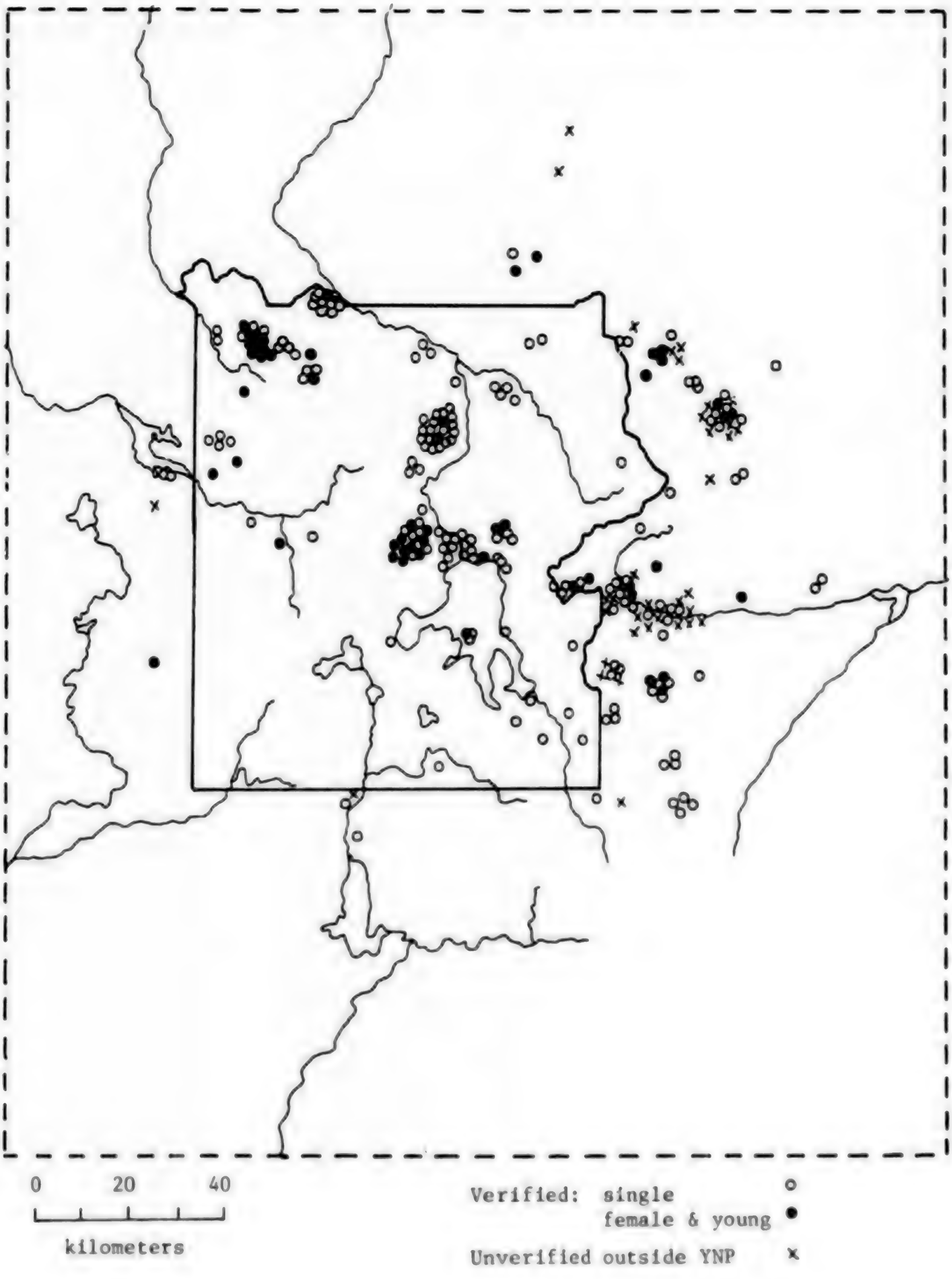


Fig. 5. Verified observations of unmarked grizzly bears during 1984.

Table 5. Summary of 1983 and 1984 radio-tracking and observation flights. Figures in parentheses are for observation flights only.

Month	No. flights		Total No. hrs		Unmarked grizzly		Grizzly bear/hr		Radio locations	
	83	84	83	84	83	84	83	84	83	84
Jan	1	2	1.70	4.85	0	0	0	0	5	8
Feb	0	0	0	0	0	0	0	0	0	0
Mar	3	2	6.18	6.50	0	1	0	0.15	15	10
Apr	7	5	23.91	18.25	2	7	0.08	0.38	41	23
May	20	7	58.85	24.58	12	2	0.20	0.08	42	26
	(12)		(35.72)		(9)		(0.25)			
Jun	19	15	56.27	62.47	12	10	0.21	0.16	34	82
	(15)		(41.43)		(8)		(0.19)			
Jul	14	21	51.99	76.86	12	46	0.23	0.60	45	97
	(7)	(8)	(21.09)	(22.24)	(7)	(27)	(0.33)	(1.21)		
Aug	18	19	73.13	64.30	12	17	0.16	0.26	68	95
	(6)	(3)	(24.05)	(6.80)	(6)	(11)	(0.25)	(1.62)		
Sep	16	9	57.51	45.75	1	3	0.02	0.07	89	70
Oct	9	9	25.67	32.22	0	1	0	0.03	55	75
Nov	1	0	1.50	0	0	0	0	0	2	0
Dec	1	0	1.50	0	0	0	0	0	2	0
Total	109	89	358.21	335.58	51	87	0.14	0.26	398	486
	(40)	(11)	(122.29)	(29.04)	(30)	(38)	(0.25)	(1.31)		

Increased numbers of ground observations during 1984 can be largely attributed to poor food conditions during late summer and fall. Bears became more visible as they sought foods associated with people. Several duplicate sightings of highly visible family groups also contributed to the inflated observations.

POPULATION PARAMETERS

Production

This study monitored 13 unduplicated females with 25 cubs during 1983, and 16 females with 29 cubs in 1984 (Table 6). One additional female, Bear 97, was known to have produced a litter in 1983, but the number of cubs was not determined before the entire litter was lost prior to July 26, 1983.

The female reproductive rate is the number of young produced per breeding female per year. A mean for the population can be obtained by dividing the number of cubs produced by total reproductive years, or dividing cubs produced each litter by number of years to the next litter and averaging. On an annual basis, reproductive rate can be estimated by dividing mean litter size by the mean reproductive cycle. Given an adequate sample, the results from all these methods should be the same.

By 1984 we had a sample of 14 reproductive cycles for nine females to calculate a mean reproductive rate of 0.568. The reproductive rate for females using supplemental food from the Cooke City dump (Bears 8 and 10) was significantly higher than the reproductive rate for females with no substantial garbage sources (Table 7). Bears 8 and 10 have been removed from the Yellowstone population, thus substantially lowering the cumulative reproductive rate to 0.482. Mean cycle length was 3.00 years and mean litter size was 1.86 cubs (for females with nogarbage source). Mean age at first cub production for 13 females was 6.15 years, with 8 of the 13 having their first cubs as 6-year-olds.

Mortality

Categories of grizzly bear mortalities included known, probable, and possible deaths. A mortality involving a retrieved carcass, or parts of a carcass, was a known mortality. Reports of a death by a reliable source (as determined by the Team Leader) with no carcass retrieved were counted as probable mortalities. Persistent and repeated rumors of a death were recorded as possible mortalities. Grizzly bear mortality rates were probably underestimated due to the difficulty involved in obtaining volunteer information concerning illegal deaths of a Federally "protected" species. Mortalities were frequently not reported until several years after the death occurred.

Mortalities from 1970 through 1984 are summarized in Table 8. Six grizzly bears died or were otherwise removed from the population in 1983 (Table 9).

Table 6. Grizzly bear females with cubs, 1974-84.

Year	Females	Cubs	Ratio	
1974	21	36	1.7	Cumulative
	15	26	1.7	Unduplicated
1975	5	8	1.6	
	4	6	1.5	
1976	36	69	1.9	
	17	35	2.0	
1977	24	43	1.8	
	13	25	1.9	
1978	15	31	2.1	
	10	19	1.9	
1979	21	39	1.9	
	13	26	2.0	
1980	13	26	2.0	
	9	19	2.1	
1981	17	32	1.9	
	13	22	1.7	
1982	17	30	1.8	
	11	21	1.9	
1983	14	26	1.9	
	13	25	1.9	
1984	40	84	2.1	
	16	29	1.8	

Table 7. Reproductive rates, 1983 and 1984.

Bear	Total cubs	No. litters	No. known cycles	Cycle lengths	Used to compute reproductive rate[1] No. litters	No. cubs
8	8	4	3	8	3	6
10	7	3	2	5	2	4
	15	7	5	13	5	10

Mean cycle length = 2.50
Mean litter size = 2.17
Reproductive rate = 8/10 = 0.800

6	3	2	1	1	1	1
12	4	3	2	4	2	3
13	1	1	1	7[2]	1	1
16	4	2	1	3	1	2
21	4	2	2	3	1	2
26	1	1	1	6	1	1
38	5	2	1	3	1	3
43	2	1	--	--	--	--
50	2	1	--	--	--	--
59	2	1	--	--	--	--
60	2	1	--	--	--	--
82	1	1	--	--	--	--
83	2	1	--	--	--	--
86	3	1	--	--	--	--
106	2	1	--	--	--	--
116	3	1	--	--	--	--
	41	22	9	27	8	13

Mean cycle length = 3.00
Mean litter size = 1.86
Reproductive rate = 13/27 = 0.482

---

[1] Unweaned cubs cannot be used to compute reproductive rate since their cycle is not complete. No. litters should not exceed No. of cycles.

[2] Cycle not complete, but at least this length.

Table 8. Grizzly bear mortalities, 1970-1984.

Year	Known	Probable	Possible	Total
1984	10	0	0	10
1983	6	0	0	6
1982	17	0	0	17
1981	9	4	2	15
1980	7	0	0	7
1979	3	6	2	11
1978	5	2	3	10
1977	13	1	1	15
1976	5	1	0	6
1975	2	1	0	3
1974	15	0	1	16
1973	10	5	3	18
1972	24	0	0	24
1971	39	3	2	44
1970	43	0	1	44
TOTAL	207	23	15	245

Table 9. Grizzly bear mortalities, 1983 and 1984.

KNOWN - 1983	
Man-caused:	
Adult, female, #10 (12 years)	Gardiner, MT 05/23/83 transport to B.C./control
Adult, male, #15 (12 years)	Rainbow Point, MT 06/26/83 dispatched/control
Yearling, male, #94 (cub of #10)	Gardiner, MT 06/18/83 dispatched/trap injury
Yearling, male, #95 (cub of #10)	Madison, YNP 07/07/83 control/transport to Missoula
Adult, female, #60 (6 years)	West Yellowstone, MT 08/22/83 control/transport to zoo
Cub, female, G17 (cub of #60)	West Yellowstone, MT 08/23/83 accidental death/in transport
KNOWN - 1984	
Man-caused:	
Subadult, female, #93 (2 years)	Indian Cr Campground, YNP 06/84 to zoo
Adult, male, #88 (7 years)	Fishing Bridge, YNP 08/84 management kill
Adult, female, #38 (13 years)	Jesse Cr, Targhee NF 09/84 accidental death/sheep allotment
Adult, male, unmarked (? years)	Targhee NF 09/84 illegal shooting
Subadult, male, unmarked (yearling)	West Yellowstone, MT 10/84 accidental trap death
Subadult, male, #113 (2 years)	Lake, YNP 10/84 to zoo
Adult, male, #105 (? years)	Shoshone NF 10/84 outfitter, illegal
Adult, female, unmarked	Targhee NF--illegal shooting 11/84
Natural:	
Cub, female, unmarked	Frank Island, YNP 06/84 malnutrition
UNKNOWN - 1984	
Adult, male, #108 ? years)	Crandall Cr, Shoshone NF 09/84

TOTAL 1983 and 1984:

Adult female = 4 ::: management control = 8
Subadult female = 3 ::: accidental (mgt.) = 3
7 ::: illegal shooting = 3
::: natural = 1
Adult male = 5 ::: unknown = 1
Subadult male = 4
9
16

All six deaths were man-caused and the result of agency control actions, and included two adult females and one female cub. Known and probable annual mortality had not been this low since 1976 when six grizzlies died. Ten grizzlies were known to die or were removed in 1984, including two adult females, one 2-year-old female, and one female cub (Table 9). Seven of the 10 deaths were caused by agency control actions, one was natural from malnutrition, one was by unknown causes, and one was an illegal shooting.

Survivorship

Survivorship by age class is illustrated in Table 10. A grizzly bear cub has a 24% chance of surviving to adulthood (5 years). An adult has only a 27% chance of living from 5 to 16 years, the prime reproductive years.

Sex and Age Structure

Since 1975 we have radio-instrumented 118 different grizzly bears. An additional four have been trapped, ear-tagged, and released; and 28 cubs and yearlings have been associated with trapped females but not tagged. Of these bears, 22 of known age were alive at some time during 1984 (17 instrumented and 5 cubs of instrumented females). Survivorship rates were applied to 74 bears not observed in 1984 and not believed to be dead: 44 radio-instrumented, 4 tagged but not radioed; and 26 untagged young of radio-instrumented females. From these grizzly bears, the age structure illustrated in Figure 6 was constructed. This age structure indicates 43% of the population is less than 5 years old (if the sample used to calculate the age structure is representative of the population). This type of age structure is characteristic of heavily hunted populations of black bears in Idaho (Beecham 1983). Unhunted populations have more older animals represented in the age structure.

The age structure of the Yellowstone population indicates a change from that during 1959-67 when garbage was available at dumps (Fig. 7). The proportion of the subadults in the population is lower than before 1967, probably a reflection of currently low subadult survival rates.

Data from tagged bears give an adult sex ratio of 0.55M:0.45F (n = 47; 5+ years) and a subadult sex ratio of 0.59M;0.41F (n = 80; cub to 4 years). The sex ratio for cubs of known litter composition was 0.55M:0.45F (n = 38 cubs in 16 litters). Cub sex ratios are different for the period 1975-79 compared to 1980-84. A sex ratio of 0.71M:0.29F was recorded for the earlier period, and 0.43M:0.57F for the later period. This discrepancy may be due to small sample sizes as only seven and nine litters could be used for the two periods.

Table 10. Grizzly bear survivorship by age class, as of January 1985.

Age	Sample	No. surviving	Percent surviving
Cub	66	58	88
1	49	37	76
2	27	15	56
3	21	17	81
4	20	16	80
5	18	15	83
6	18	17	94
7	15	14	93
8	12	11	92
9	11	9	82
10	11	11	100
11	11	11	100
12	9	6	67
13	6	5	83
14	8	7	88
15	5	5	100
16	4	2	50
17	2	1	50
18	2	2	100
19	2	2	100
20	2	2	100
21	2	2	100
22	2	1	50

Mean Adult 5+ = 81%
Mean subadult 2-4 = 72%

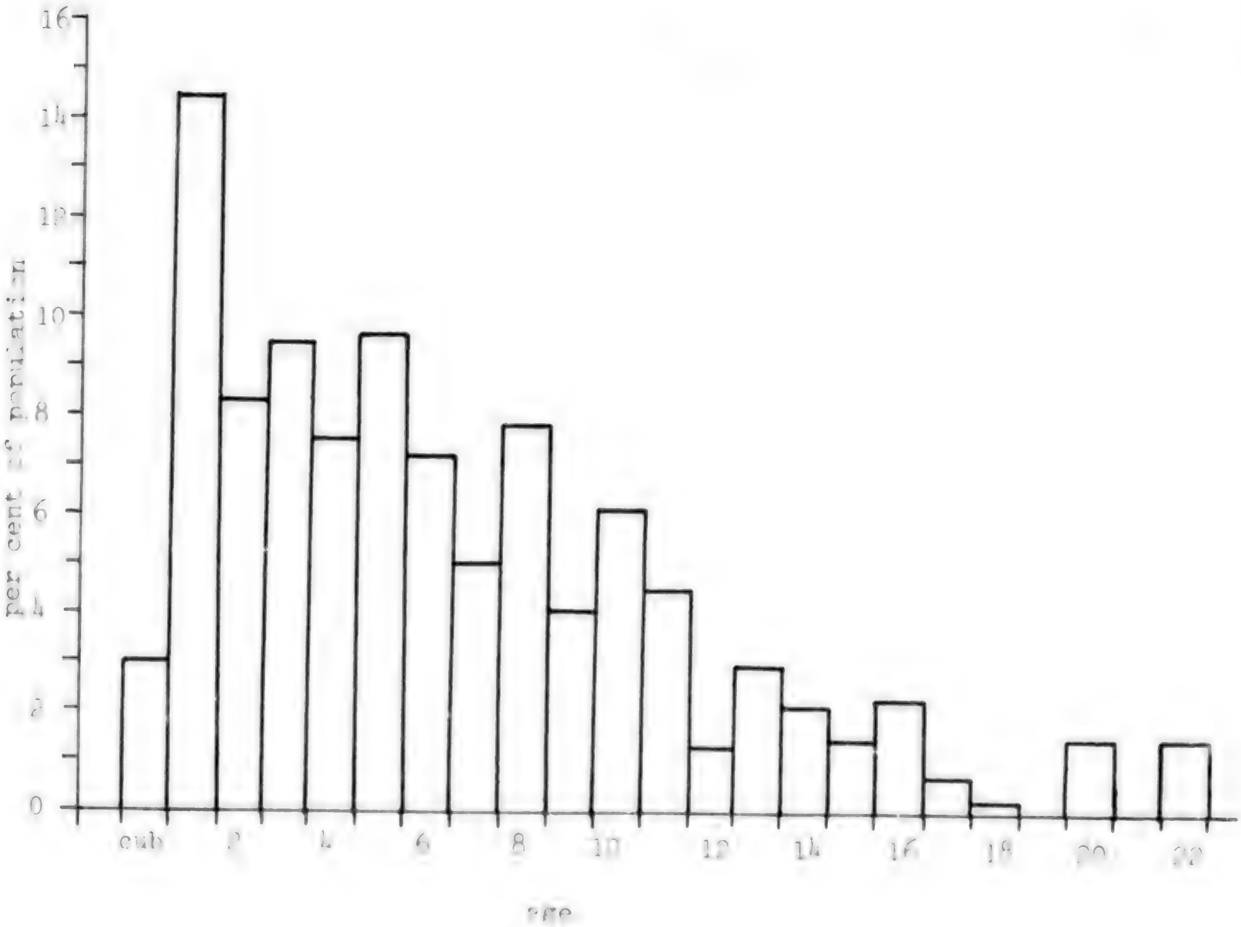


Fig. 6. 1984 age structure.

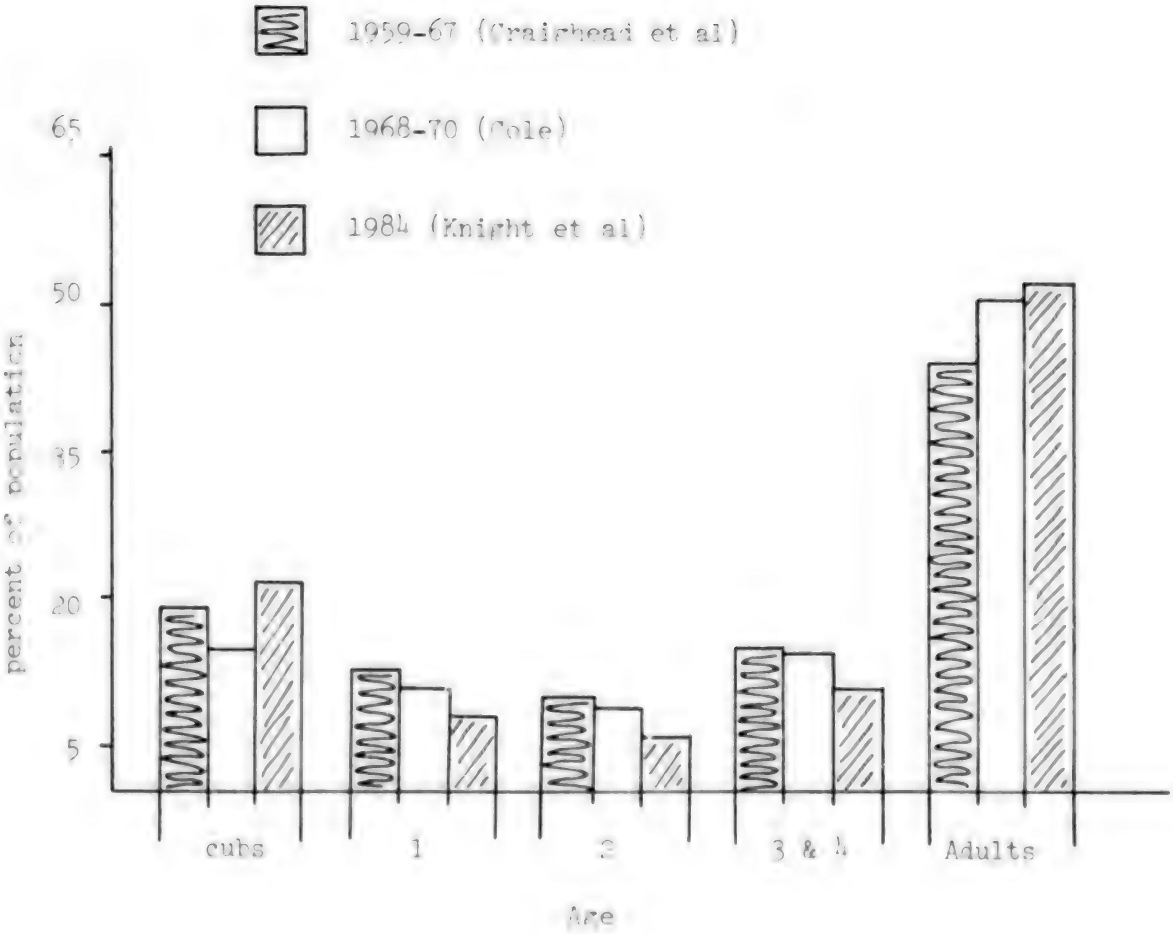


Fig. 7. Age structure comparisons from 1959-67, 1968-70, and 1984.

FOOD HABITS

Procedures

Yellowstone grizzly bear food habits were determined from scat analysis and ground investigation of feeding sites. Scats were collected whenever encountered during investigations of aerial relocations (relocation sites) of instrumented bears. The contents were assumed to be representative of the food habits of the bears in the study area for 1983. Scats collected during 1984 represented food habitats for only a portion of the study area centered on Hayden Valley and the Washburn Range.

All bear scats collected (grizzly, black, and species unknown) were included in the analysis. Hair samples were collected from all day beds (n = 100) encountered during 1979. Analysis of the samples (Picton and Knight 1980) revealed 70% were from grizzly bear and 17% were from black bear. The remaining 12% were not from bear. Dried scats were soaked in water to soften them and washed through two screens. Coarse material was retained in the large screen (holes 0.125 in.) and fine material, including seeds, was collected in the small screen (holes 0.0328 in.). All items were identified to species when possible, and the percent volume of each item was visually estimated.

Procedures used in the ground investigation of feeding sites are described by Blanchard (1983) and Blanchard (in prep.). Because feeding activities produce evidence of varying observability and longevity, site examinations were not used alone to determine food habits. Site examinations provide data on habitat use and preference; these examinations also provide data on feeding behavior which produces long lasting sign. Easily digestible food items which are rarely revealed through scat analysis (such as mushrooms) are often evident at the feeding site. The more digestible items are probably under-represented in scat contents and, therefore, in the food habits analysis.

Whitebark pine *(Pinus albicaulis)* cone production was monitored to determine annual variation in the amount of pine nuts available to bears. Nine 90-m transects were established in whitebark pine stands in the study area during 1980 (Fig. 8). Ten whitebark pine trees were selected along each transect and marked with a blaze and an aluminum identification tag. The crown of selected trees could be viewed from the ground from at least two angles. Cones were counted in July and early August when they had reached mature size, but few had been harvested by squirrels. All trunks joined at the base were considered one tree.

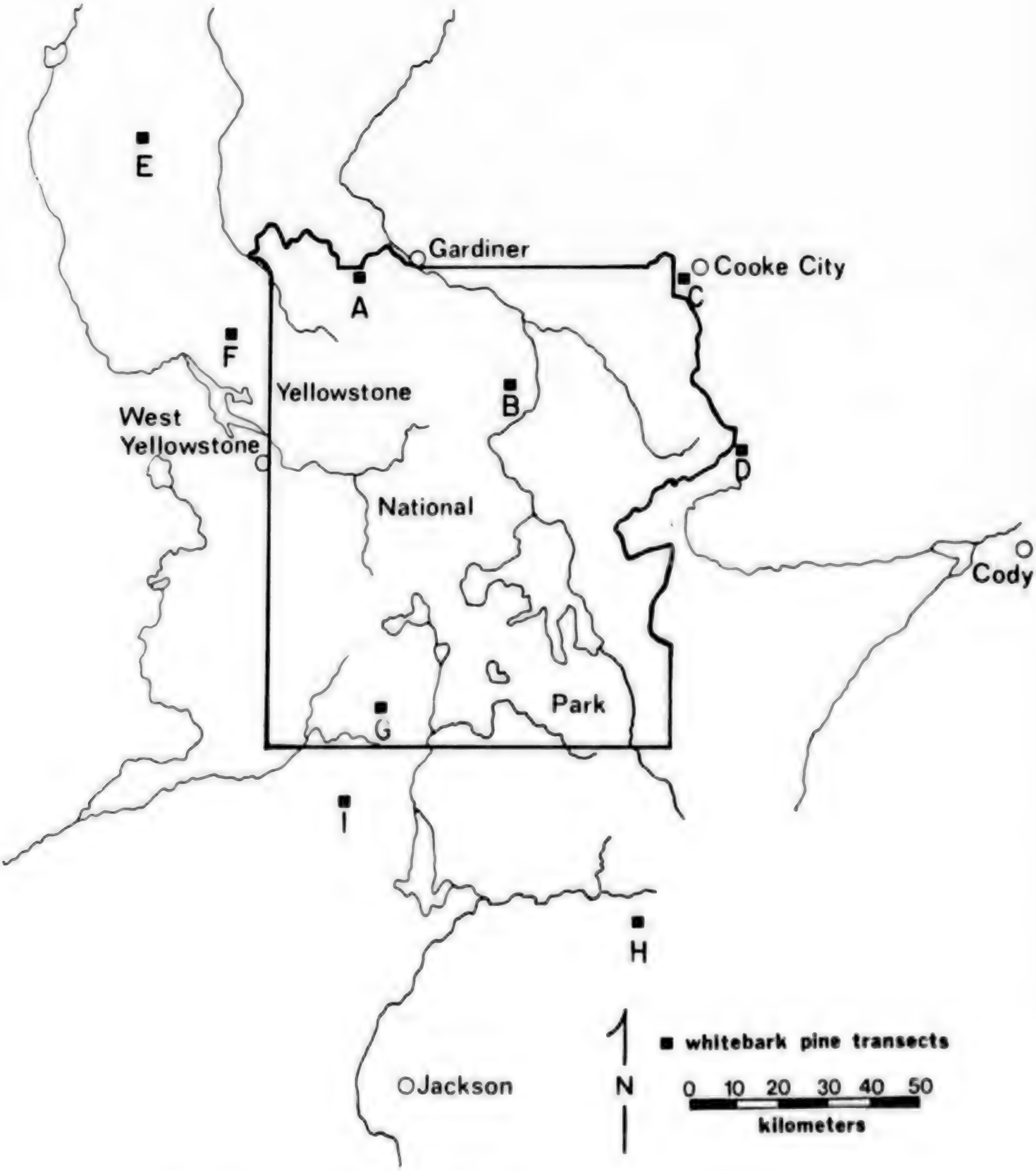


Fig. 8. Locations of whitebark pine cone production transects.

Results

Scat analysis from 1983.--In 1983, 395 scats were collected and analyzed for content (Table 11). Scats for which date of deposition could be estimated totaled 33 spring (April-May), 190 summer (June-August), and 16 fall (September-October) scats.

Mammals were the most frequently (66.7%) consumed food item during the spring and also constituted the greatest scat volume (48.0%) (Table 12). Elk occurred in 50% of the April scats and 33% of the May scats. Food items with the highest composition per scat were elk (100%), marmot (95%), and grizzly bear (80%).

During summer, graminoids were consumed most frequently (82.1%) and in the greatest volume (45.8%). Forbs were second in frequency and volume, with dandelions most commonly consumed in June; dandelions and thistles in July; and dandelions, claytonia and lomatium in August. Other common food items during summer were horsetail, ants, cutthroat trout, elk, and grouseberry. Food items with the highest composition per scat were graminoids (100%), pine nuts (100%), dandelion (90%), bison (100%), and lagomorphs (100%).

During fall, mammals were again the most frequently consumed food item, especially during October when moose constituted 43% of the scat volume and occurred in 50% of the scats. Other fall food items were buffaloberry, grouseberry, ants, pine nuts, and graminoids. Food items with the highest composition per scat were pine nuts (100%), moose (100%), and dandelion (100%). Only 16 scats were collected September-October, and food habits reflected by content analysis of those 16 scats are probably not representative of the entire study area. The whitebark pine nut transects and locations of radio-collared grizzly bears both indicate that use of pine nuts in the fall of 1983 was higher than revealed by scat analysis. Fifty-five percent of the radio locations during September and 84% during October were at or above 8500-ft elevation and/or specifically noted to be in whitebark pine. Whitebark pine transects indicated nut production was better in 1983 than either 1981 or 1982 when both the frequency and volume of pine nuts in scats were higher. Evidence of spring and early summer grizzly bear use of whitebark pine nuts during 1984 corroborates that pine nut production during 1983 was substantial. Pine nut production must have been sufficient to exceed winter and spring red squirrel requirements.

Scat analysis from 1984.--In 1984, 426 scats were collected and analyzed for content (Table 13). Scats for which data of deposition could be estimated totaled 15 spring (March-May), 343 summer (June-August), and 8 fall (September) scats.

Scats collected during 1984 were not representative of food habits for the entire study area, as most were located during specific studies in the Antelope Creek/Washburn Range and Hayden Valley areas of central Yellowstone Park. Seasonal grizzly bear diet in this area characteristically includes

Table 11. Bear scat content analysis, 1983 (N = 395).

Food item	No. scats	% Frequency occurrence	% Diet volume	% Scat composition
Trees				
Pinus albicaulis (pine nuts)	5	1.3	0.8	62.0
Shrubs				
Shepherdia canadensis	10	2.5	0.4	14.2
Vaccinium scoparium	6	1.5	0.6	40.0
Total	14	3.5	1.0	27.3
Sporophytes				
Equisetum sp.	29	7.3	3.4	45.9
Lycopodium sp.	1	0.3	0.1	20.0
Total	29	7.3	3.4	46.6
Graminoids				
Agropyron sp.	1	0.3	0.2	85.0
Bromus sp.	8	2.0	0.4	21.9
Calamagrostis sp.	1	0.3	0.1	35.0
Carex sp.	12	3.0	0.9	28.8
Melica sp.	1	0.3	0.2	65.0
Melica spectabilis	1	0.3	0.2	85.0
Phleum alpinum	1	0.3	0.1	50.0
Poa sp.	10	2.5	0.9	35.0
Triticum sp.	3	0.8	0.4	50.0
Grass	1	0.3	0.3	100.0
Grass/sedge	214	54.2	31.1	57.4
Total	246	62.3	34.7	55.8
Forbs				
Allium sp.	1	0.3	0.1	30.0
Cirsium sp.	7	1.8	0.7	41.4
Cirsium scariosum	18	4.6	2.5	54.4
Claytonia lanceolata	5	1.3	0.3	26.0
Crepis sp.	1	0.3	0.1	50.0
Heracleum sp.	1	0.3	0.2	60.0
Heracleum lanatum	1	0.3	0.1	30.0
Lomatium cous	4	1.0	0.5	48.8
Polygonum sp.	4	1.0	0.2	18.8
Ranunculus sp.	1	0.3	<0.1	15.0
Taraxacum sp.	69	17.5	5.4	31.0
Taraxacum officinale	2	0.5	0.3	55.0
Tragopogon sp.	38	9.6	4.2	43.3
Trifolium sp.	42	10.6	2.5	23.5
Umbelliferae/Apiaceae	2	0.5	0.1	12.5
Total	169	42.8	18.7	43.6

Table 11. Continued.

Food item	No. scats	% Frequency occurrence	% Diet volume	% Scat composition
Mammals				
Large mammal (unidentified)	10	2.5	1.0	38.0
Elk	56	14.2	5.2	36.5
Bison	4	1.0	0.4	36.3
Microtus sp.	1	0.3	0.1	30.0
Deer	7	1.8	0.3	19.3
Marmot	1	0.3	0.2	95.0
Moose	6	1.5	1.2	76.7
Grizzly bear	53	13.4	7.6	56.3
Lagomorph	1	0.3	0.3	100.0
Small mammal (unidentified)	2	0.5	0.3	100.0
Microtinae	5	1.3	0.5	39.0
Total	139	35.2	16.7	47.4
Insects				
Ants	106	26.8	3.6	13.4
Fish				
Cutthroat trout	29	7.3	2.7	37.2
Birds				
Unidentified bird	4	1.0	<0.1	3.0
Miscellaneous				
Garbage	6	1.5	0.2	15.0
Wood	26	6.6	1.0	14.5
Trap bait	17	4.3	0.8	18.0
Dirt	232	58.7	15.1	25.7
Rocks	32	8.1	0.7	8.6
Needles	16	4.1	0.7	17.6
Total	254	64.3	18.2	28.3

Table 12. Seasonal bear scat content analysis by major food items, 1983.

	Spring[1]			Summer[2]			Fall[3]		
	No. scats	% freq.	% vol.	No. scats	% freq.	% vol.	No. scats	% freq.	% vol.
Trees	0			2	1.1	0.7	1	6.3	6.3
Shrubs	0			9	4.7	1.4	1	6.3	3.8
Grass/sedge	15	45.5	27.0	156	82.1	45.8	5	31.3	20.6
Forbs	7	21.2	7.9	105	55.3	20.7	2	12.5	8.1
Mammals	22	66.7	48.0	30	15.8	4.2	9	56.3	30.3
Insects	6	18.2	1.1	52	27.4	2.9	3	18.8	3.1
Birds	1	3.0	0.2	3	1.6	<0.1			
Other	27	81.8	14.5	103	54.2	13.0	10	62.5	26.6
	33			190			16		

[1] Spring = April, May
[2] Summer = June, July, August
[3] Fall = September, October

Table 13. Bear scat content analysis, 1984 (n = 426).

Food item	No. scats	% Frequency occurrence	% Diet volume	% Scat composition
Trees				
Pinus albicaulis (pine nuts)	40	9.4	7.5	80.0
Shrubs				
Ribes sp.	1	0.2	0.2	80.0
Shepherdia canadensis	1	0.2	0.1	20.0
Vaccinium globulare	1	0.2	0.2	75.0
Vaccinium scoparium	14	3.3	2.5	74.6
Total	17	4.0	2.9	71.8
Sporophytes				
Equisetum sp.	11	2.6	1.3	71.8
Graminoids				
Bromus sp.	4	0.9	0.2	21.2
Calamagrostis sp.	2	0.5	0.2	40.0
Carex sp.	11	2.6	1.2	47.3
Melica sp.	3	0.7	0.3	43.3
Phleum alpinum	1	0.2	0.1	25.0
Poa sp.	9	2.1	0.9	43.9
Grass	9	2.1	1.5	72.2
Grass/sedge	185	43.4	26.1	60.1
Total	221	51.9	30.5	58.8
Forbs				
Cerastium sp.	1	0.2	<0.1	15.0
Cirsium scariosum	27	6.3	4.1	65.0
Cirsium sp.	2	0.5	0.3	70.0
Claytonia lanceolata	5	1.2	0.3	27.0
Fragaria sp.	2	0.5	<0.1	7.5
Heracleum lanatum	7	1.6	0.9	54.3
Heracleum sp.	21	4.9	3.0	61.2
Hydrophyllum capitatum	1	0.2	0.1	20.0
Lomatium triternatum	2	0.5	0.3	55.0
Mertensia sp.	1	0.2	0.1	35.0
Perideridia gairdneri	28	6.6	2.7	40.4
Polygonum bistortoides	1	0.2	0.1	40.0
Taraxacum officinale	43	10.1	6.2	61.6
Taraxacum sp.	26	6.1	2.5	40.8
Tragopogon dubius	19	4.5	2.5	56.3
Tragopogon sp.	2	0.5	0.1	22.5
Trifolium sp.	22	5.2	1.9	36.1
Umbelliferae/Apiaceae	5	1.2	0.4	37.0
Total	188	44.1	26.3	59.6

Table 13. Continued.

Food item	No. scats	% Frequency occurrence	% Diet volume	% Scat composition
Mammals				
Elk	33	7.8	3.2	41.8
Bison	29	6.8	3.3	48.6
Rodent	1	0.2	<0.1	5.0
Pocket gopher	10	2.4	0.8	32.0
Microtus sp.	14	3.3	1.4	43.2
Deer	14	3.3	0.9	27.9
Marmot	2	0.5	0.2	45.0
Grizzly bear	1	0.2	0.2	70.0
Black bear	1	0.2	0.2	75.0
Lagomorph	2	0.5	0.1	25.0
Small mammal (unidentified)	1	0.2	0.1	30.0
Spermophilus citellus	2	0.5	0.1	27.5
Tamiasciurus sp.	3	0.7	0.3	40.0
Microtinae	4	0.9	0.3	32.5
Total	121	28.4	11.6	40.9
Insects				
Ants	124	29.1	3.8	13.2
Coleoptera	1	0.2	0.2	65.0
Total	125	29.3	4.0	13.6
Birds				
Unidentified bird	3	0.7	0.1	11.7
Miscellaneous				
Garbage	6	1.4	0.9	65.0
Wood	3	0.7	0.3	48.3
Trap bait	9	2.1	0.4	18.9
Dirt	197	46.2	14.1	30.5
Rocks	1	0.2	<0.1	20.0
Total	202	47.4	14.9	31.4

large volumes of pine nuts, relatively low volumes of graminoids, and substantial amounts of yampa.

During 1984 mammals were the most frequently (60%) consumed food item during spring, although graminoids constituted the greatest scat volume (36.7%) (Table 14). Elk occurred in 67% of the April scats and 27% of the May scats. Food items with the highest composition per scat included horsetail (100%), Carex (75%), and black bear (75%).

During the summer graminoids were consumed most frequently (54.8%) and in the greatest volume (31.1%). Forbs were second in frequency and volume, with dandelions most commonly consumed in June; dandelion, cow parsnip, and thistle in July; and yampa and clover in August. Other commonly consumed items were ants, bison, and elk. Food items with highest composition per scat were dandelions (100%), cantaloupe (100%), grouse whortleberry (90%), buffaloberry (80%), and gunny sacks (80%).

During September, whitebark pine nuts were consumed most frequently (50%) and in the greatest volume (50%). Food items with the highest composition per scat included pine nuts (100%) and thistle (95%). Only eight scats were collected during September, and no scats were collected during October and November. Whitebark pine transects and locations of radio-collared bears indicated the fall of 1984 was very poor for pine nut production. Only 21% (16 of 75) of the radio locations during October were at elevations of 8500 ft or above compared to 84% during October 1983 when bears were foraging on pine nuts. Mean elevation of all radio-telemetered grizzlies during October was 7847 ft compared to a mean of 8835 ft in 1983. All of the 16 grizzly bears trapped during September and October 1984 were the result of management actions involving bears obtaining food from people.

Monthly food habits based on volumetric analysis of scats indicated 1984 was very similar to 1977, a generally poor food year. Virtually no pine nuts were available during the fall of either year, while yampa and large mammals were consumed in greater quantities.

Comparison of the average summer diet in the Hayden Valley/Mt. Washburn area with the diet estimated by scat analysis for 1984 (Figs. 9 and 10) shows substantive differences. Major deviations of 1984 from the 1977-82 average include much greater consumption of rodents, ungulates, and dandelion; greater consumption of graminoids during June; and much less consumption of biscuitroot and whitebark pine nuts.

These deviations conform with dietary changes expected in response to climatic conditions and availability of pine nuts during 1984. Spring temperatures during the early growing season of 1984 (April through June) were near or below normal while precipitation amounts were generally near or above normal. Soil moisture was therefore very likely abundant at the peak of the growing season and enhanced favorable late growing season (July through August) conditions of above normal precipitation and temperatures. Although some overwintered whitebark pine nuts were available in squirrel

Table 14. Seasonal bear scat content analysis by major food items, 1984.

	Spring[1/]			Summer[2/]			Fall[3/]		
	No. scats	% freq.	% vol.	No. scats	% freq.	% vol.	No. scats	% freq.	% vol.
Trees	0			12	3.5	2.1	4	50.0	50.0
Shrubs	0			15	4.4	3.3	1	12.5	8.8
Grass/sedge	8	53.3	36.7	188	54.8	31.1	3	37.5	25.6
Forbs	0			175	51.0	30.4	1	12.5	11.9
Mammals	9	60.0	30.0	97	28.3	11.2	0		
Insects	2	13.3	1.0	107	31.2	4.1	1	12.5	1.9
Birds	0			1	0.3	<0.1	0		
Other	12	80.0	32.3	177	51.6	16.7	1	12.5	1.9
	15			343			8		

[1/] Spring = March-May
[2/] Summer = June-August
[3/] Fall = September

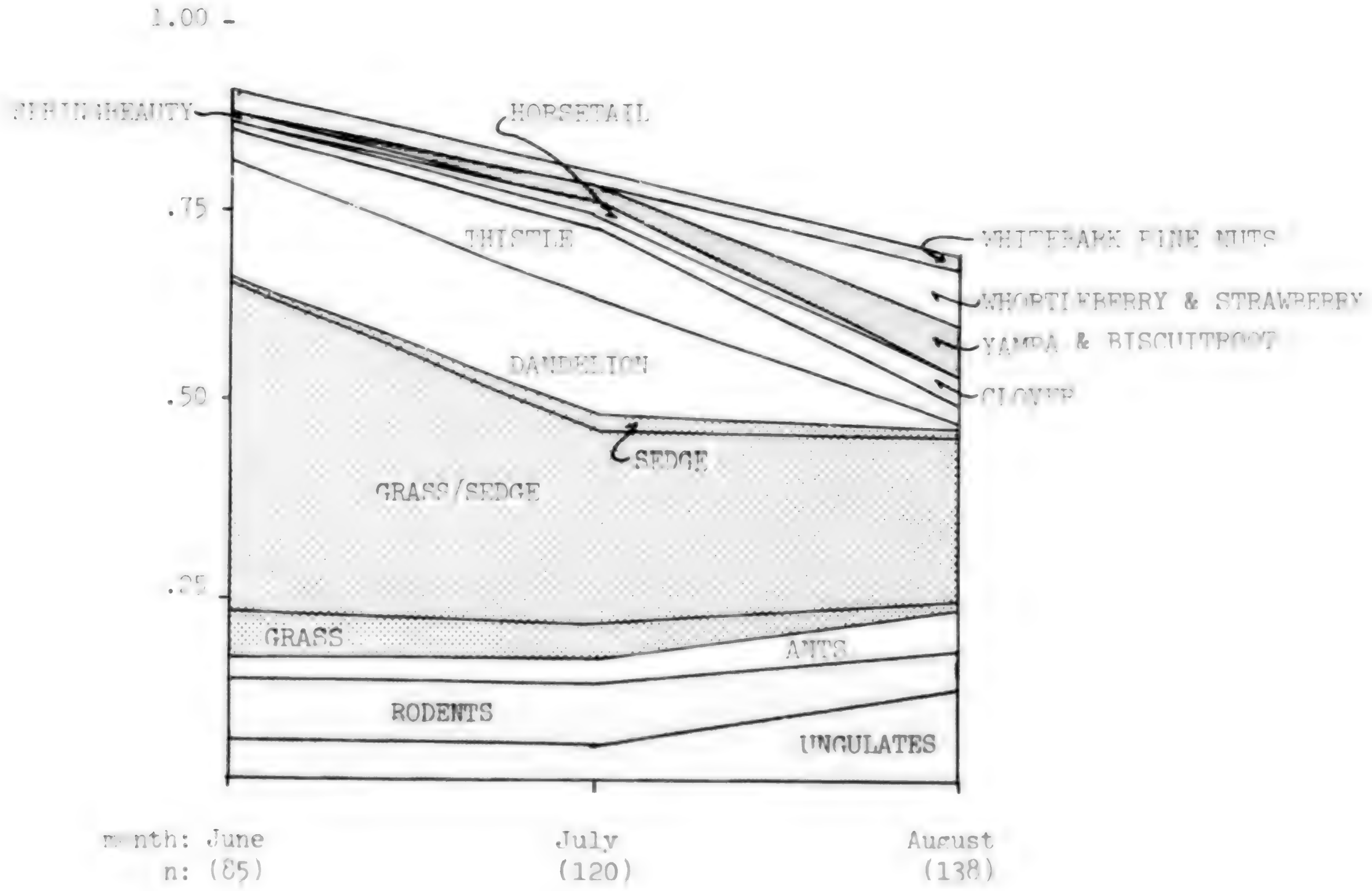


Fig. 9. Volumetric analysis of grizzly bear scats during summer 1984 for central Yellowstone National Park. Sample sizes are given in parentheses by month.

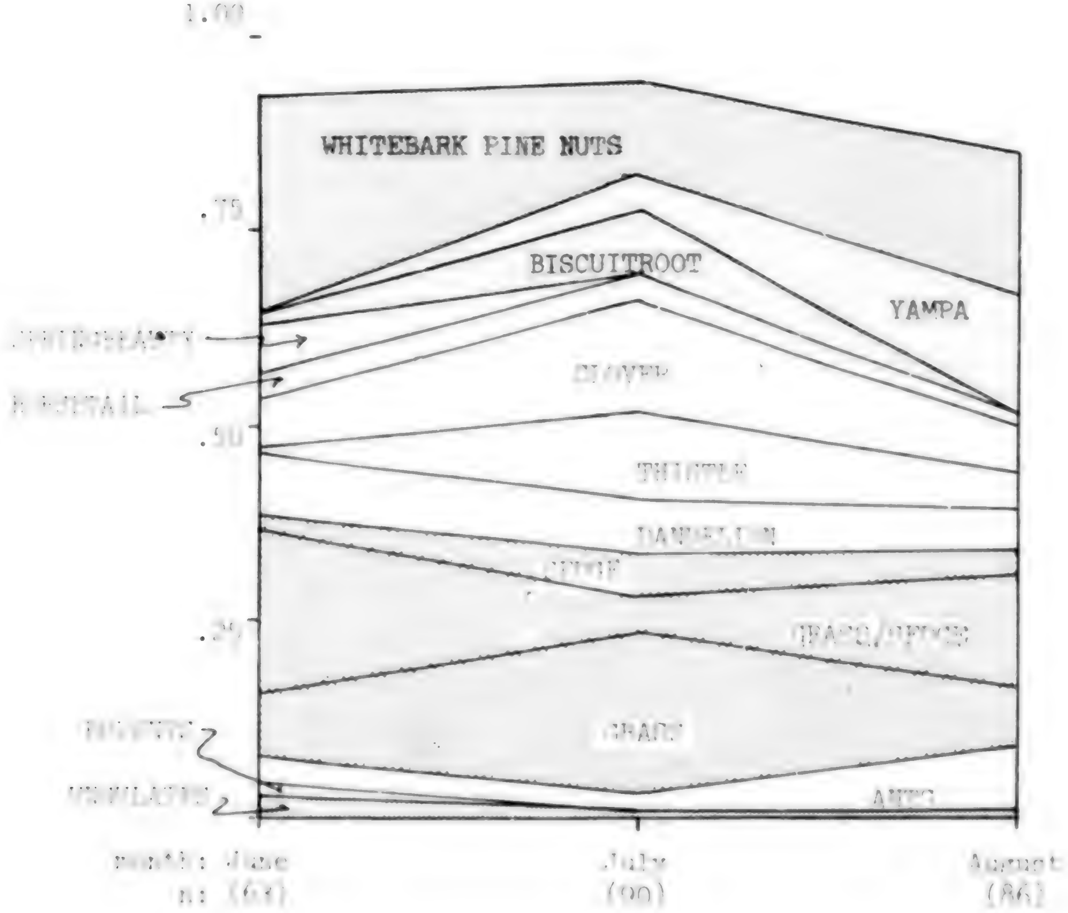


Fig. 10. Average volumetric analysis of grizzly bear scats during summer, 1977-1984, for central Yellowstone National Park. Sample sizes are given in parentheses by month.

middens during spring of 1984, the amounts would not likely have approached those of springs 1979 and 1981.

Analysis of 1977-1982 diets suggests that during years of more favorable vegetal growing conditions, as during 1984, consumption of dandelions is greater and consumption of biscuitroot and ants is less. The greater consumption of dandelion and lower consumption of especially biscuitroot during 1984 compared to the 1977-82 average conforms well to this prediction. Our analysis of diet also suggests that during summers when few pine nuts are consumed, consumption of graminoids and mammals is greater. The 1984 diet compared to the average also follows these predictions. The relatively large volume of rodents and ungulates consumed during 1984 also conforms with a trend towards increased consumption of these diet items during summer and fall.

Whitebark pine cone production transects.--Whitebark pine cone production has been recorded at nine locations throughout the study area during July and August from 1980 through 1984 (Table 15). Highest cone production in the 5-year period was during 1980 (mean = 26 cones/tree) when all transects produced at or above the overall mean of 14 cones/tree (Table 16). The least variation among transects was also observed that year. The lowest producing year was 1984 (mean = 6 cones/tree). Two transects on the Shoshone National Forest were not counted during 1984; consequently, cone production east of the park could only be speculated. However, the high number of incidences involving grizzlies at low elevations on the Shoshone during late summer and fall suggests that cone production was also low in this area.

Whitebark pine nuts are by far the most important fall food of Yellowstone grizzlies, and availability of pine nuts influences their fall movements. Activity is focused at lower elevations during falls of generally low nut production, as during 1981, 1982, and 1984. Bears subsequently search for alternate food, often in association with people. For example, all 19 captures of grizzlies from mid-August through October 1984 were management actions taken in response to bears obtaining food in association with people.

In general, years of poor whitebark pine nut production result in high mortality rates. Mortality averaged 13 bears during years when pine nut production was poor (1977, 1981, 1982, 1984) compared to an average of seven a year for other years.

By knowing the nut production in an area during July, we should be able to predict potential intensity of grizzly/human conflicts during late summer and fall of the year. Predictions are based on past experience and corresponding pine nut production records.

There has been a significant difference between and within transects in both cone production and crown diameter of the trees. The difference in cone production can be explained by crown diameter in all significant cases except when transect H (Moccasin Basin) was added to the analysis. Small

AVAILABLE

Table 15. Number of cones in 10 whitebark pine trees at nine locations, 1980-1984.

	Tree										Mean	
Transect	1	2	3	4	5	6	7	8	9	10	cones/tree	Avg
A	0[1/]	10	47	2	7	4	14	38	25	80	23	
	12[2/]	36	11	1	6	0	24	23	27	138	28	
YNP	11[3/]	12	22	4	3	D[6/]	1	17	41	30	16	18
	7[4/]	35	10	22	19	D	23	30	9	32	21	
	4[5/]	3	1	0	0	D	1	0	0	5	2	
B	20	25	10	34	35	26	31	6	20	28	24	
	17	0	2	27	10	16	0	7	8	0	9	
YNP	192	45	10	49	39	14	27	12	20	55	46	20
	0	13	10	31	15	26	9	15	16	5	14	
	8	3	9	23	5	11	3	2	9	2	8	
C	7	8	23	6	23	20	0	8	4	40	14	
	4	0	13	3	5	6	4	11	2	6	5	
SNF	28	6	36	25	6	15	4	11	7	18	16	12
	6	10	19	13	30	13	1	16	0	13	12	
	DATA NOT COLLECTED FOR 1984											
D	18	19	19	5	12	6	19	8	6	32	14	
	12	10	14	6	15	11	5	5	4	7	9	
SNF	10	5	7	17	8	15	17	12	10	34	14	13
	10	30	13	12	40	5	3	7	6	29	16	
	DATA NOT COLLECTED FOR 1984											
E	32	26	21	16	28	14	6	18	16	14	19	
	0	0	0	2	0	0	3	0	3	0	1	
GNF	0	0	0	0	0	0	0	0	0	0	0	7
	3	15	5	5	17	29	6	2	3	41	13	
	4	1	4	0	0	0	2	0	15	3	3	
F	25	11	51	50	51	169	20	60	65	60	56	
	0	0	5	0	0	0	5	3	1	0	1	
GNF	0	0	0	0	0	0	0	0	0	0	0	14
	75	10	20	12	7	81	5	0	32	23	27	
	DATA NOT COLLECTED FOR 1984											
G	35	8	50	52	12	90	53	5	28	18	35	
	3	1	5	50	18	20	22	3	22	0	14	
YNP	1	0	5	28	D	8	3	15	8	0	8	14
	1	0	10	38	D	0	33	3	2	0	10	
	0	0	9	6	D	D	6	0	D	0	3	

Table 15. Continued.

Transect	Tree 1	2	3	4	5	6	7	8	9	10	Mean cones/tree	Avg
H	30	25	9	24	30	13	18	28	47	24	25	
	45	24	18	99	36	50	60	45	100	12	49	
SNF	14	4	38	2	20	17	57	100	110	34	40	33
	43	28	27	17	43	71	27	30	79	7	37	
	12	5	10	7	11	10	11	12	38	8	12	
I	42	11	0	18	12	26	14	11	65	16	22	
	4	1	0	2	0	0	1	5	15	0	3	
TNF	9	2	0	D	8	D	D	25	21	19	12	12
	TRANSECT DISCONTINUED; J substituted beginning 1983											
J	12	3	6	10	11	1	5	7	10	13	8	
TNF	12	2	12	11	30	8	6	6	2	8	10	9

1/ 1980
2/ 1981
3/ 1982
4/ 1983
5/ 1984
6/ D = dead

Table 16. Total annual whitebark pine cone production.

Year	n	Mean No. cones/tree	Standard deviation	Coefficient of variation	Range	Total cones
1980	90	25.69	23.87	92.92	0-169	2313
1981	90	13.23	22.85	172.65	0-138	1191
1982	85	16.98	27.63	162.73	0-192	1443
1983	88	17.97	17.61	97.94	0-81	1528
1984	56	6.43	7.28	113.30	0-38	360

crown diameters are associated with low cone production. Trees with large crown diameters (>75 dm) produce significantly more cones than those with intermediate (50-75 dm) or small (<50 dm) crown diameters. Transect H is an exception. Trees there yield more cones for any given crown diameter than trees in any other transect. Preliminary analysis indicates crown diameter of whitebark pine trees in the study area is dependent on a combination of factors including age and vigor of the tree, and environmental conditions of the site.

Average ages of whitebark trees in the transects are 140-180 years, with the oldest well over 200 years and the youngest about 70 years. The youngest trees are in transect I which is also one of the poorest producing transects.

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